IDENTIFICATION OF POTENTIAL COMMERCIAL NAVIGATION RELATED BANK EROSION SITES

I. INTRODUCTION

A. Background. In order to assess the existing bank conditions, the Upper Mississippi Districts of the U.S. Army Corps of Engineers (COE); Rock Island, St. Louis, and St. Paul; conducted an extensive field survey of bank erosion along the Upper Mississippi River (UMR) between St. Paul, Minnesota and Cairo, Illinois, and the Illinois Waterway (IWW) between Joliet, Illinois and Grafton, Illinois during the fall of 1995. A report entitled "Bank Erosion Field Survey Report of the Upper Mississippi River and Illinois Waterway," was published by COE in January 1998 (COE, 1998). The report provides detailed information about site-specific bank and subaqueous conditions existing at the time of the survey.

Upon completion of the field survey, a follow-up study was initiated to utilize the site-specific field observations to assess the relative risk of bank erosion for the existing and future conditions for the study area (a decision point paper describing the overall scope and purpose of the add-on study is contained in Appendix A). This report addresses the effort to achieve this goal. The scope of this study included the construction of a GIS database of information collected during the field survey; the development of a model to identify locations where there is a high, medium, or low risk of navigation contributing to bank erosion; and the system wide implementation of the model. The scope of work for the model development and application is presented in Appendix B. A contract for the development of the bank erosion model was awarded to SENES Oak Ridge Inc., who obtained the services of Dr. Tatsuaki Nakato of the Iowa Institute of Hydraulic Research (IIHR). Dr. Nakato had previously participated in the aforementioned field survey and prepared the UMR portion of the field survey report.

B. Summary of Available Models. At the initiation of the Bank Erosion Study, an extensive literature review of available pertinent data, research, and opinions regarding the process of bank erosion along the UMR and IWW was conducted by the Waterways Experiment Station (CEWES-Technical Report HL-96-10, August 1996). Special emphasis was placed on selecting methodologies which could be used to identify and differentiate between the various mechanisms contributing to bank erosion throughout the system, as well as a means of establishing the relative significance of each mechanism.

The literature search revealed that much of the research conducted has been in reference to navigation effects and bank protection. Research containing actual relationships between navigation processes, or any processes for that matter, and bank erosion were rare and often unverified in the field. Only two articles were identified which presented a shoreline retreat model related to wave energy. One, Grigor'eva (1987), was unverified and showed a conceptual method for bank reworking due to wind waves only. The second, Nanson et al. (1993), was a study conducted on the Gordon River in Australia. The authors measured erosion rates while recreation boats passed a site. A good correlation was found between wave power or wave height and erosion. Based on their observations, they developed a set of maximum wave height thresholds for various soil types and recommended appropriate vessel speed restrictions.

The lack of applicable models and need for further research was expressed in many articles. This nature is best described in an article by Pilarczyk et al. (1989): "*The mechanisms of bank erosion and the stability of protection structures subject to hydraulic loading are complex problems. The understanding of erosion processes and failure mechanisms of structures is still in a rudimentary stage, and it is not yet possible to describe many important phenomena and their interactions by theory*."

At the present time, no computational method exists for linking a commercial vessel with chosen hull shape, traveling at a chosen speed in a channel of chosen depth and chosen cross-sectional area and shape with banks of a chosen height and materials, to a predicted occurrence of erosion. Therefore, there is no existing modeling technique, nor does this paper purport to develop one, that can predict or quantify bench erosion based on physical forces associated with commercial navigation. The model developed by this study is an effort to relate observed erosion, which may or may not be related to navigation, to various parameters associated with navigation through the use of contingency[1] analysis.

II. ASSESSMENT OF DATA

A. Available Data. During the 1995 field survey, data on detailed bank and channel conditions were collected at forty-three erosion sites along the UMR. In addition,

[1] A statistical method of testing the independence of two variables; both of which must be categorical (e.g., minor, moderate, and severe) as opposed to continuous numeric values.